

11. Notes on some of the Viscera of an Okapi (*Okapia johnstoni* Sclater). By R. H. BURNE, M.A., F.Z.S.

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(Text-figures 1-23.)

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During the winter of 1915-1916 certain parts of the viscera of an Okapi were sent by Dr. Cuthbert Christy to the Royal College of Surgeons for investigation.

They included the tongue and the soft parts of the anterior end of the throat, the contents of the thorax, the stomach, and the colic coil of the intestine.

A superficial examination revealed, as was to be expected, a general similarity to the corresponding viscera of the Domestic Ruminants, but a more detailed comparison with other genera* made it clear that underlying this general Ruminant type of structure were many small and individually unobtrusive peculiarities that pointed definitely to a very close relationship between the Okapi and the Giraffe.

The Tongue (text-figs. 1 & 2).

The tongue of the Okapi, though of the Ruminant type, resembles most nearly that of the Giraffe, both by reason of its great length and slenderness (it measures some 14 in. in length by from $1\frac{1}{2}$ to 2 in. in breadth) and its sharp pointed extremity and smooth base. It is thus distinguished from the tongues of Antelopes and Deer, the tip of which is as a rule either blunt or broadly spatulate, and in which the surface of the elevated base or intermolar fixed portion is covered with large fleshy papillæ.

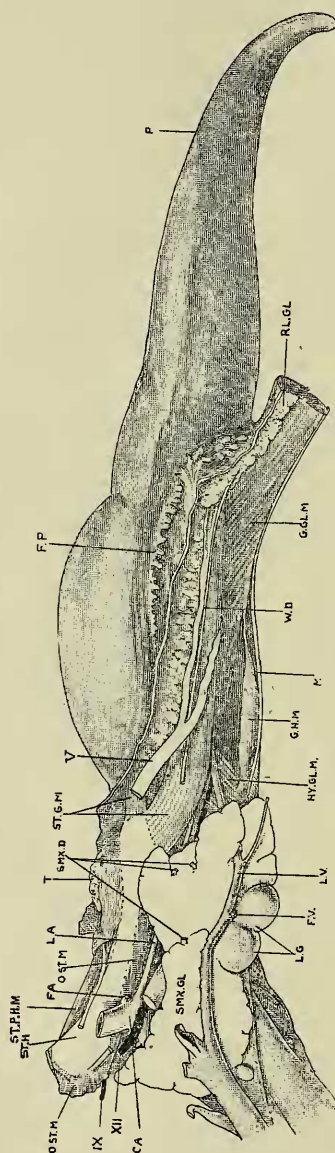
It is manifestly difficult to state with accuracy the relative measurements of a tongue or the proportions that its different parts bear to one another, as they depend on its degree of extension; but after comparison with numerous tongues of Antelopes and other Ruminants, both fresh and preserved, it seems fairly clear that the free part of the Okapi's tongue is considerably more developed relative to the base than is that of other Ruminants, with the exception of the Giraffe.

The form and disposition of the various papillæ upon the surface of the tongue differ little from those in the Giraffe, and are

* I am indebted to the Zoological Society for material for use in the comparative study of the throat and tongue,—Giraffe, Crowned Duiker, Indian Antelope, Black Buck, Siemmering's Gazelle, and *Gazella rufifrons*.

Use was also made of preparations in the Royal College of Surgeons Collection of the tongue and larynx of many Ruminants, of the heart and lungs of Ox, Sheep, and Goat, and of the stomach of a young Giraffe and of several Antelopes and the Domestic Ruminants.

Text-figure 1.

Lateral view of the tongue and pharynx of *Okapia johnstoni*.

ca., carotid artery; *cr.th.m.*, cricothyroid muscle; *fa.*, facial artery; *f.p.*, fringe of lateral lingual papillae; *f.v.*, facial vein; *g.gl.m.*, genio-glossus muscle; *g.h.m.*, geniohyoid muscle; *h.gl.m.*, hyoglossus muscle; *la.*, lingual artery; *l.gl.*, lymph-glands; *l.v.*, lingual veins; *m.m.*, mylohyoid muscle; *o.st.m.*, occipito-styloideus muscle; *p.*, limit of pigmented area of tongue; *r.l.gl.*, retro-lingual gland; *st.gl.*, sublingual gland; *s.mar.gl.*, submaxillary gland; *s.mar.d.*, collecting ducts of submaxillary gland; *st.g.m.*, styloglossus muscle; *st.h.*, stylohyal; *sh.m.*, sterno-hyoid muscle; *st.hy.m.*, stylohyoid muscle; *st.ph.m.*, stylo-pharyngeal muscle; *st.th.m.*, sterno-thyroid muscle; *t.*, tonsil; *W.d.*, Wharton's duct.

V. Lingual nerve. IX. Glosso-pharyngeal nerve. XII. Hypoglossal nerve.

characteristically Ruminant. The dorsal surface and sides are clothed with a close layer of sharp-pointed filiform papillæ which are more or less cornified, particularly so upon a central area of the dorsal surface close behind the tip, where they form a patch of small horny recurved spines.

Fungiform papillæ are scattered sparsely all over those parts of the free extremity and base that are coated with filiform papillæ except, as one frequently sees among Ruminants, along the central line of the dorsum.

Circumvallate papillæ, to the number of 15 or so on either side, are arranged in two indistinct irregular rows far back upon each side of the base of the tongue. This is the normal Ruminant position and arrangement, but the indistinctness of the individual papillæ and of the limits of the group as a whole recall more particularly the condition in the Giraffe.

There are no foliate papillæ, and, as previously mentioned, the base of the tongue is smooth, as in the Giraffe.

Text-figure 2.



Lingual papillæ of *Okapia johnstoni*.

In a large number of Ruminants (nearly all Antelopes; the Giraffe, some Sheep and Oxen, but not in Deer) parts of the free extremity of the tongue are deeply pigmented. This also is the case in the Okapi, where the pigmented area includes the extreme tip of the tongue and extends some way backwards on either lateral surface, gradually fading away (text-fig. 1, *p.*).

In the valley between the base of the tongue and the gums, there is in all Ruminants a fold of mucous membrane fringed by a number of sharp-pointed papillæ similar in character and probably also in function to the conical papillæ that clothe the inner surface of the cheeks.

A similar fringe of fleshy papillæ lies beside the base of the tongue of the Okapi; but whereas in all the other Ruminants examined the papillæ are simple conical processes flattened from side to side and usually recurved like the thorns of a rose, in the Okapi they have quite a peculiar shape, being swollen and blunt with two three or more short, sharp horny spines projecting from their rounded free extremities (text-fig. 2).

The Muscles of the Tongue and Pharynx.

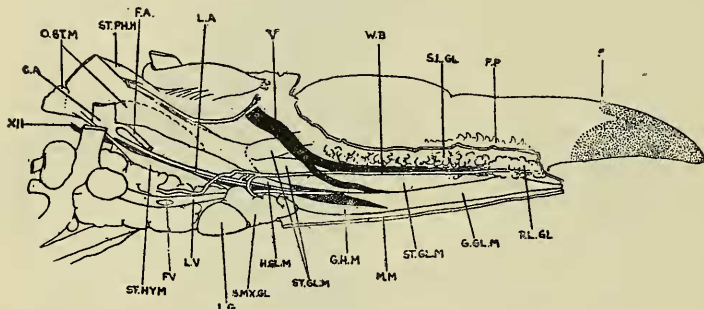
The muscles of the tongue conform in general to the common Ruminant type, but in the details of their arrangement and individual development disclose more points of agreement with the Giraffe than with any of the other Ruminants examined.

A comparison of the accompanying figures (figs. 1, 3, 4, 5, 6) shows more readily than a verbal description how close the similarity between the Okapi and Giraffe in respect of these muscles is. Attention may, however, be drawn to the following particulars.

Digastric, Mylohyoid, Geniohyoid, and Genioglossus Muscles.

Blending of the various muscles in the floor of the mouth to a varying degree is typical of Ruminants in general. In the majority, if not in all genera, the anterior belly of the digastric muscle and the mylohyoid are so closely united that where they

Text-figure 3.



Outline of the tongue and pharynx of a Giraffe, for comparison with text-fig. 1.

Lettering as in text-fig. 1.

blend in the superficial sheet of the mylohyoid it is impossible to distinguish the one from the other. The deeper muscles (geniohyoid and genioglossus) are, as a rule, more independent. Generally the former has a weak fibrous attachment along the central line of the mylohyoid, and very occasionally (e.g. *Antelope cervicapra*) it unites with the genioglossus close up to the symphysis menti, but as a rule it is a well-developed paired muscle independent of its neighbours.

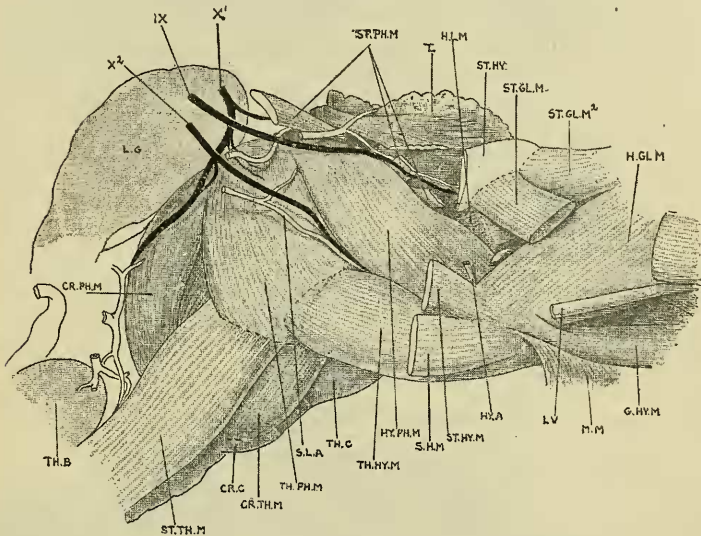
In the Okapi and Giraffe, not only is the association of the digastric and mylohyoid peculiarly intimate, but there is also a very close fibrous union between the deep layer of the mylohyoid and the geniohyoid and a blending of the geniohyoid and genioglossus.

The geniohyoid is also very much reduced in both these

genera, and can only with difficulty be separated into its two component halves.

The condition is shown in text-figs. 1 and 3. It will be noticed that the belly of the geniohyoid extends only about halfway from the hyoid to the symphysis menti, and is continued upon the ventral surface of the genioglossus as a flat tendon from which a large part of the latter muscle arises.

Text-figure 4.



Dissection of the pharynx of *Okapia johnstoni*.

cr.c., cricoid cartilage; *cr.ph.m.*, crico-pharyngeal muscle; *h.l.m.*, hyoideus latus muscle; *hy.a.*, hyoidean branch of lingual artery; *hy.ph.m.*, hyopharyngeal muscle; *l.g.*, cervical lymph-gland; *s.l.a.*, superior laryngeal artery; *st.g.m.²*, lesser styloglossus muscle; *st.ph.m.*, slips of stylo-pharyngeal muscle; *th.c.*, thyroid cartilage; *th.b.*, thyroid body; *th.hy.m.*, thyro-hyoid muscle; *th.ph.m.*, thyro-pharyngeal muscle.

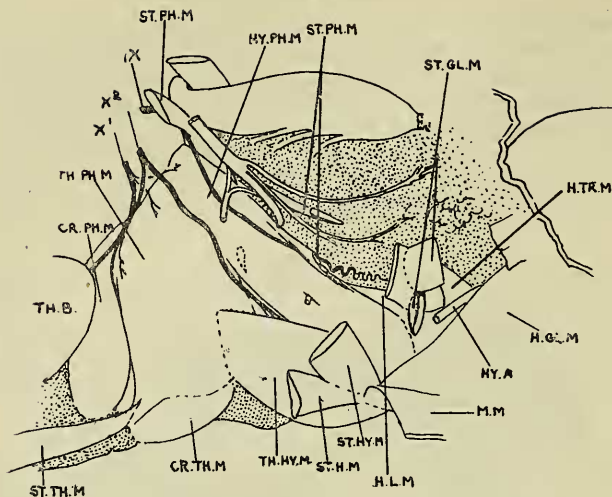
X¹. Pharyngeal branches of vagus. X². Superior laryngeal branch of vagus.

Other lettering as in text-fig. 1.

Stylohyoid Muscle.

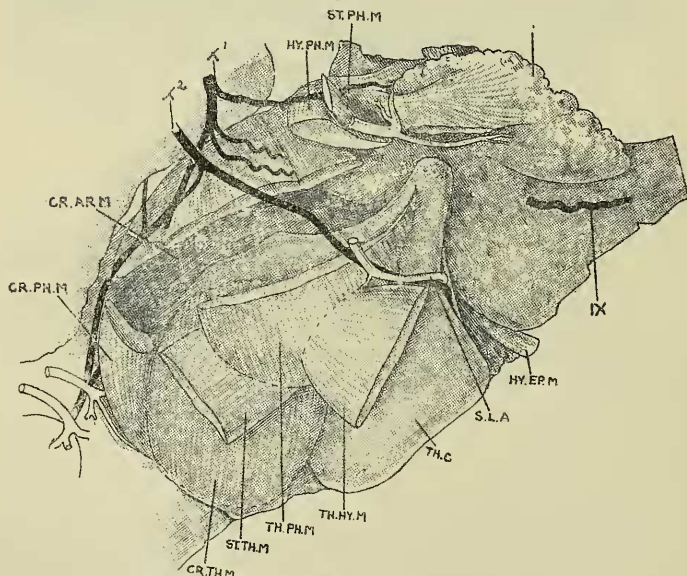
The round tendon of origin of this muscle differs a good deal in length in different genera of Ruminants. It is relatively short in Antelopes, considerably longer in the Okapi and Sheep, and longer again, though not by much, in the Giraffe.

Text-figure 5.



Outline of the pharynx of a Giraffe, for comparison with text-fig. 4.
h.tr.m., hyoideus transversus muscle. Other lettering as in text-fig. 4.

Text-figure 6.



Superficial dissection of the larynx of *Okapia johnstoni*.

cr.ar.m., crico-arytenoid muscle; *cr.ph.m.*, crico-pharyngeal muscle; *cr.th.m.*, crico-thyroid muscle; *hy.ep.m.*, hyo-epiglottidean muscle; *hy.ph.m.*, hyo-pharyngeal muscle; *s.l.a.*, superior laryngeal artery; *st.ph.m.*, stylo-pharyngeal muscle; *t.*, tonsil; *th.c.*, thyroid cartilage; *th.ph.m.*, thyro-pharyngeal muscle.
 IX. Glosso-pharyngeal nerve. X¹. Pharyngeal branches of vagus. X². Superior laryngeal nerve.

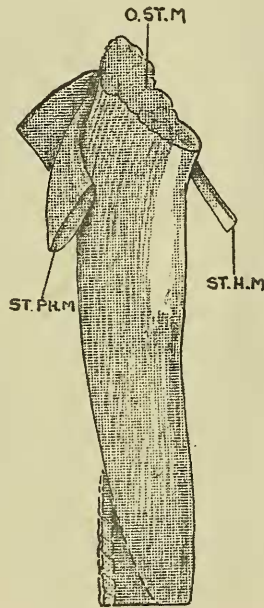
Occipito-styloideus (text-figs. 7, 8, 9, *o.st.m.*).

This muscle is peculiar to Ungulates, and extends from the styloid process of the occipital to the upper portion of the styloid bone.

In the Giraffe and Okapi it was far larger than in any of the other Ruminants examined (Antelopes and Sheep), and offers in these two genera a striking contrast to the same muscle in Antelopes, particularly as regards the area of the styloid bone covered by its insertion.

In connection with the insertion of this muscle it should be noted that the styloid bone of the Giraffe and Okapi differs markedly from that of other Ruminants in the form of its upper extremity (text-fig. 10).

Text-figure 7.



The upper end of the stylohyal of *Okapia johnstoni*, inner surface, showing the insertion of the occipito-styloideus muscle.

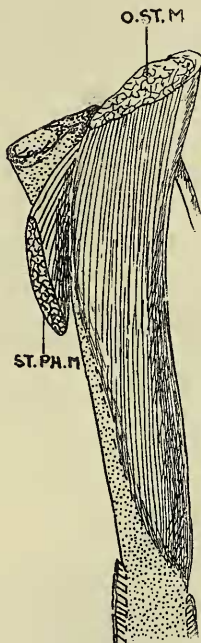
o.st.m., occipito-styloideus muscle; *st.h.m.*, tendon of stylohyoid muscle;
st.ph.m., stylo-pharyngeal muscle.

In Ruminants in general, the posterior margin of this bone, close to its upper end, is produced to form a prominent angular process, to the tip of which is attached the tendon of the stylohyoid muscle. This process stands out more or less transversely to the length of the bone and shows a tendency to a downward

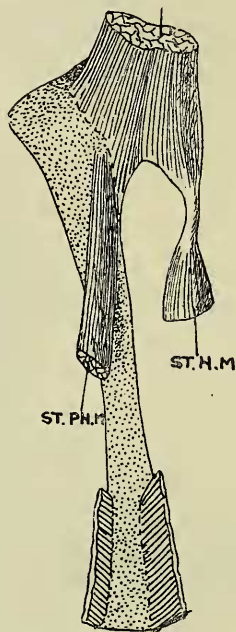
curve, forming in some Antelopes (text-fig. 10, B) a veritable hook, and in all cases offers a very broad surface for the insertion of the occipito-styloideus muscle.

In the Giraffe and Okapi (text-fig. 10, A) and in the Camels and the Perissodactyl Ungulates the process is relatively small, and is directed upwards, forming a simple swelling or tuberosity of the upper end of the styloid bone.

Text-figure 8.



Text-figure 9.



Text-fig. 8.—The stylohyal of a Giraffe, showing the occipito-styloideus muscle.

Text-fig. 9.—The stylohyal of Sæmmering's Gazelle, showing the occipito-styloideus.

Lettering as in text-fig. 7.

Salivary Glands.

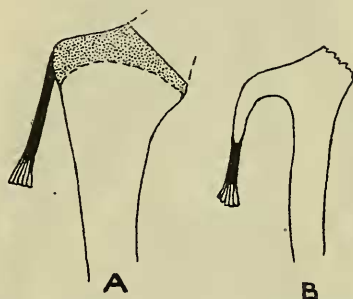
The submaxillary gland (text-figs. 1, 3, *smx.gl.*) is similar in position, form, and relative size in the Giraffe and Okapi, and is closely comparable also to the same gland in Antelopes and Domestic Ruminants.

In the Giraffe and Okapi the gland gives off two main tributary ducts, one from its posterior and one from its anterior end. The parts drained by these two collecting ducts can be readily and completely separated from one another in the Giraffe, but this is not the case in the Okapi.

The two tributary ducts unite in the Giraffe (the junction was destroyed in the Okapi) close in front of the gland to form a single Wharton's duct (text-fig. 3, *Wd.*), and there is no reason to think that the separate lobule drained by the anterior tributary is anything but a part of the submaxillary gland, for the retro-lingual gland, which at first sight it might be supposed to be, is represented in Ruminants, including the Okapi and Giraffe, by a mass of gland-tissue surrounding the anterior extremity of Wharton's duct close behind the symphysis of the jaw, between the origin of the genioglossus muscle and the sublingual mucous membrane (text-figs. 1, 3, *rl.gl.*).

The sublingual gland calls for no comment. The parotid gland had been removed with the skin.

Text-figure 10.



Upper end of stylohyal of (A) *Okapia* and (B) *Sæmmering's Gazelle*.

The Blood-vessels of the Tongue (text-figs. 11, 12, 13).

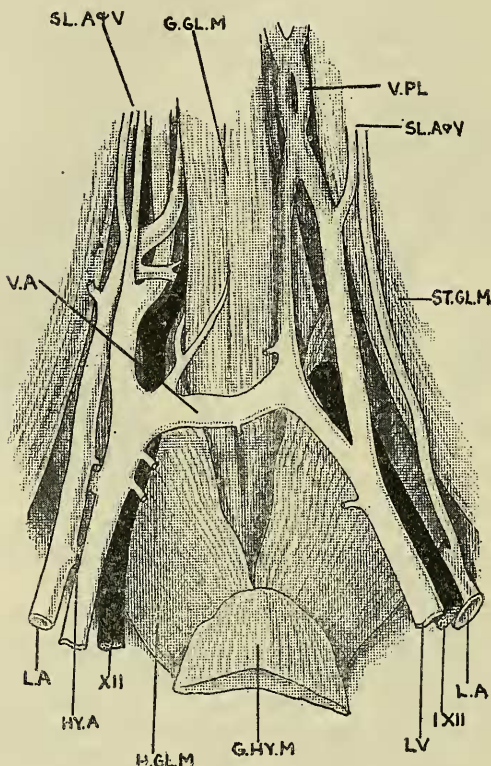
In his description of the anatomy of the Giraffe, Owen* mentions a peculiar plexiform arrangement of the veins close in front of the body of the hyoid bone. In this position there is generally among Ruminants a large venous anastomosis uniting the lingual veins of either side. This anastomosis was strongly developed in the Giraffe's tongue (text-fig. 11, *v.a.*) dissected for comparison with that of the Okapi, and in front of it, upon the left side (text-fig. 11, *v.pl.*), there was some slight branching and reunion of the veins, suggesting the plexus mentioned by Owen. There was no indication of a plexus in the Okapi (text-fig. 12).

Posteriorly, the lingual vein passes through the substance of the submaxillary gland, and where it emerges again to the surface receives the facial vein (text-fig. 1, *f.v.*). At this spot lies a very definite lymph-gland, which in the Giraffe lies embedded in the substance of the salivary gland, and by its dark colour forms a very striking object when the surface of the gland is exposed.

* Owen, Trans. Zool. Soc. vol. ii. 1841, p. 223.

In the Okapi, Antelopes, and Sheep this lymph-gland is not so deeply embedded as in the Giraffe, and in the Okapi (text-fig. 1, *l.g.*) consists of two globular masses separated from the submaxillary gland by a capsule of fibrous tissue.

Text-figure 11.



Blood-vessels at the root of the tongue of a Giraffe.

g.gl.m., genioglossus muscle; *g.hy.m.*, geniohyoid muscle; *h.gl.m.*, hyoglossus muscle; *hy.a.*, hyoidean branch of lingual artery; *l.a.*, lingual artery; *l.v.*, lingual vein; *sl.a. & v.*, sublingual artery and vein; *st.gl.m.*, styloglossus muscle; *v.a.*, venous anastomosis; *v.pl.*, venous plexus.

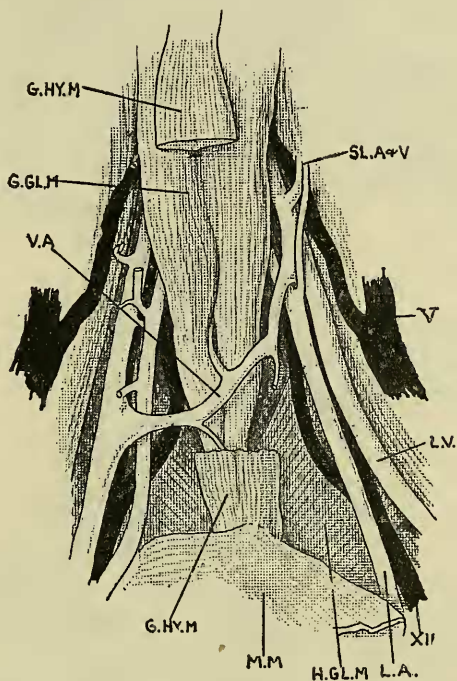
XII. Hypoglossal nerve.

The lingual arteries of the Okapi and Giraffe agree in many particulars and show several, though small, differences from those of Antelopes.

In both, the lingual artery arises from the carotid independently of the facial (text-figs. 1, 3, *f.a.*), as it is stated to do normally

in the Sheep* and Goat, and occasionally in the Ox. In Antelopes, on the other hand, a common trunk (the arteria maxillaris externa) intervenes between the carotid and the lingual and facial arteries, dividing to form these two arteries about the middle of the submaxillary gland.

Text-figure 12.

Blood-vessels at the root of the tongue of *Okapia johnstoni*.

m.m., mylohyoid muscle turned back.

Other lettering as in text-fig. 11.

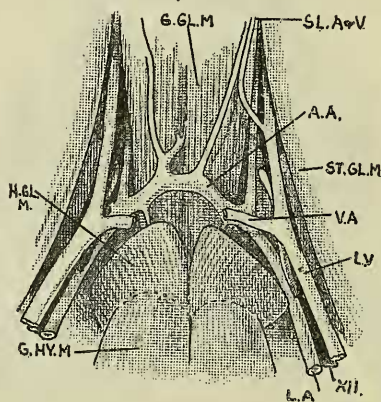
In passing the hyoid region of the tongue, the main trunk of the lingual artery may lie either deep or superficial to the hyoglossus muscle. In the Antelopes (text-fig. 13, *l.a.*) and Sheep it lies deep to this muscle, and in this position forms in the Antelopes a strong anastomosis (text-fig. 13, *a.a.*) with its fellow of the opposite side, from which are given off the continuation of the main lingual artery, the sublingual artery, and branches to the muscles of the hyoid region.

* In the Sheep dissected it was given off from an external maxillary trunk as in the Antelopes.

In the Okapi (text-fig. 12) and on one side in the Giraffe (text-fig. 11), the lingual arteries, after giving off a large branch to the hyoid region, passed superficially to the hyoglossus muscle, and in neither case was there any anastomosis between the vessels in this region. Nor was I able to trace in either of these genera the large connection between the lingual arteries at the commencement of the free portion of the tongue described by Owen in the Giraffe.

On the other hand, I can corroborate the fact mentioned by Owen that in the Giraffe the left lingual artery greatly exceeds the right in size (text-fig. 11), and carries practically the whole blood-supply to the free part of the tongue.

Text-figure 13.



Blood-vessels at the root of the tongue of an Indian Antelope.

a.a., anastomosis of the lingual arteries.

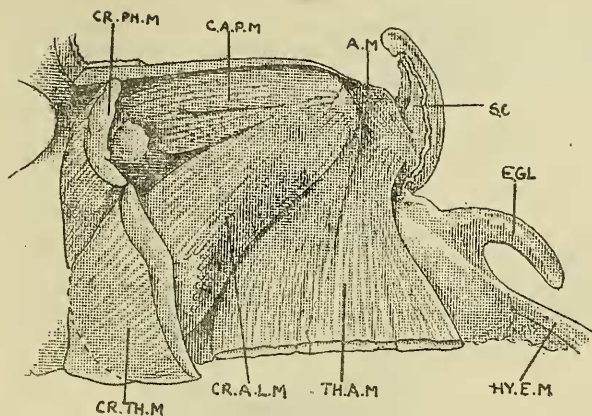
Other lettering as in text-fig. 11.

This is not, however, the case in the Okapi or among Antelopes and Sheep. In them the two lingual arteries are of equal size, but it should be noted that in the Okapi the left artery divides at the commencement of the free part of the tongue into a large ventral and a small dorsal branch, and thus provides the chief source of supply to the ventral parts of the extremity of the tongue, as it does in the Giraffe, the dorsal parts being supplied by the right artery and the smaller branch of the left.

The Larynx (text-figs. 14, 15, 16).

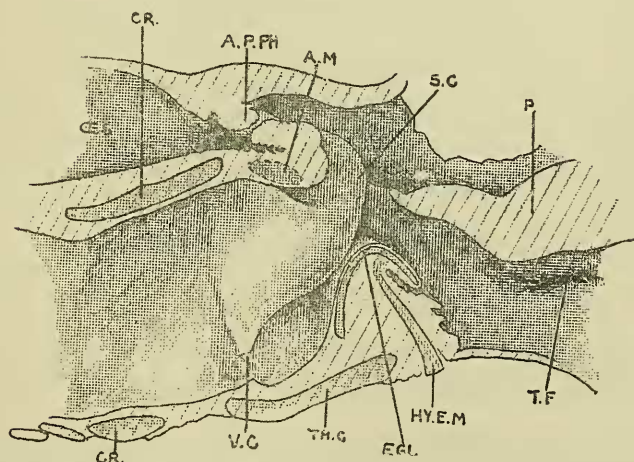
The larynx of the Okapi presents a remarkably close resemblance to that of the Giraffe, and by its structure suggests that the animal, like the Giraffe, is practically mute. In general it

Text-figure 14.

Muscles of the larynx of *Okapia johnstoni*.

a.m., arytenoid muscle; *c.a.l.m.*, crico-arytenoid lateral muscle; *c.a.p.m.*, crico-arytenoid posterior muscle; *c.ph.m.*, crico-pharyngeal muscle; *c.th.m.*, crico-thyroid muscle; *e.gl.*, epiglottis; *h.y.e.m.*, hyo-epiglottidean muscle; *th.a.m.*, thyro-arytenoid muscles; *s.c.*, cartilage of Santorini.

Text-figure 15.

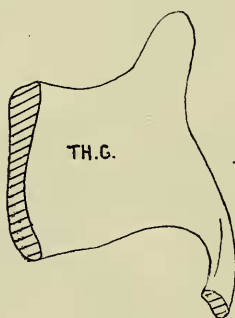
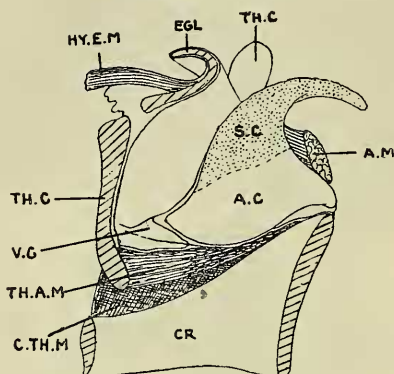
Longitudinal section of the pharynx and larynx of *Okapia johnstoni*.

a.c., arytenoid cartilage; *a.p.ph.*, arcus palato-pharyngeus (posterior pillar of fauces); *cr.*, cricoid cartilage; *æs.*, œsophagus; *p.*, soft palate; *t.f.*, tonsillar fossa; *th.c.*, thyroid cartilage; *v.c.*, vocal cord.

Other lettering as in text-fig. 14.

has the simple form common to Ruminants. The eminence supported by the arytenoid and Santorini's cartilages is peculiarly large and prominent (text-fig. 14, *s.c.*). The general cavity (text-fig. 15) is quite simple, without recesses or pouches of any kind, and, as in the Giraffe, the vocal cords (text-fig. 15, *v.c.*) are

Text-figure 16.



Longitudinal section of the larynx of *Okapia johnstoni*, showing the cartilages.

Lettering as in text-figs. 14 & 15.

extremely rudimentary, represented only by minute folds connecting the ventral extremities of the enormous arytenoids to the mid-line of the thyroid cartilage. The cartilages (text-fig. 16) closely resemble those of the Giraffe. The muscles (text-fig. 14) are similar to those of other Ruminants, and call for no special comment.

The Tonsils (text-figs. 1, 4, 6).

The tonsillar fossa of the Okapi lies in the usual position (text-fig. 15, *t.f.*), between the anterior and posterior pillars of the fauces somewhat in advance of the hinder free margin of the palate. It is a simple oval pit, with its fundus subdivided into two or more subsidiary recesses. The fossa and the area surrounding it are covered externally by a nodulated mass of tonsillar tissue, which is encapsulated by a thin longitudinal sheet of muscle derived from the muscles of the palate.

The tonsils are thus of quite a usual Ruminant type, and very similar to those of the Giraffe. It is interesting, however, to note that in many Ruminants the single fossa is replaced by a row of separate incisions, which no doubt represent the subsidiary recesses in the fundus of the common fossa of the Okapi.

The Palate.

In 1915 the Royal College of Surgeons purchased the roughly prepared skeleton of a young male Okapi collected by Dr. Christy, in which the soft tissues covering the hard palate had not been removed. They are shown in the accompanying photograph (text-fig. 17).

In front of the molar region the palate is extremely narrow, and throughout this region is traversed by a series of about 15 major palatal ridges. The anterior three or four are weak and do not extend across the entire breadth of the palate; they are succeeded by some twelve or so more complete ridges bowed forward in the centre and with their free papillate edges directed backwards. In the middle line these ridges are interrupted, the right half of each being situated in the majority of cases slightly posterior to the left. Behind the level of the anterior molar teeth, the palatal ridges become less and less pronounced and more nearly transverse in direction and gradually fade away, leaving the greater part of the intermolar area of the palate quite smooth.

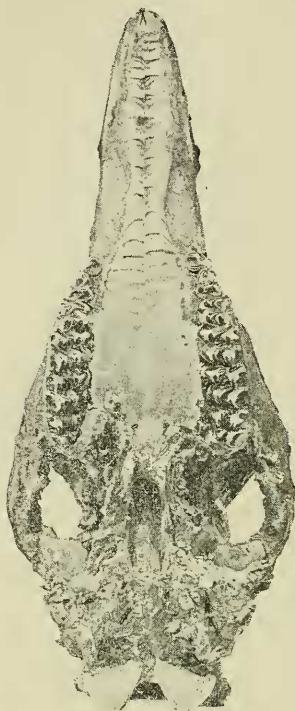
Between the major palatal ridges are series of papillæ arranged transversely, forming minor ridges.

As in the Giraffe, there is no papilla incisiva, but at the extreme anterior end of the palate, in front of the palatal ridges, are two little longitudinal slits—the openings of the naso-palatine canals.

The soft palate terminates posteriorly in a simple curved border, without any indication of a uvula. Its lateral parts are prolonged, as the posterior pillars of the fauces, and become confluent upon the dorsal wall of the pharynx, forming, as in the majority of quadrupeds, a complete circular lip (arcus palato-

pharyngeus) (text-fig. 15, *a.p.ph.*) through which the nasal passage communicates with the pharynx.

Text-figure 17.



Palate of *Okapia johnstoni*.

The Thyroid Body.

The thyroid body, as in many other Ruminants (Sheep, Antelopes, Giraffe), consists of the lateral lobes only, without a connecting portion or isthmus between them.

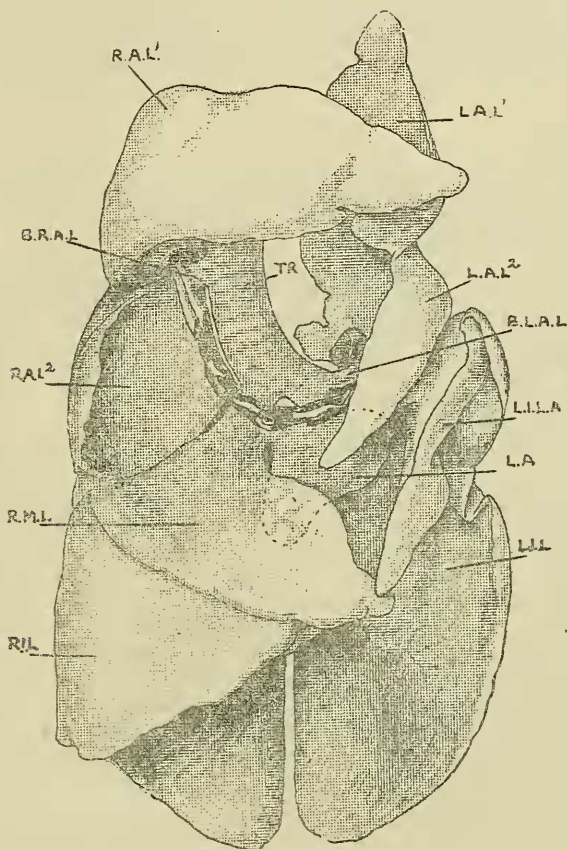
Each lobe is an oval body measuring 47 mm. in length $\times$ 16 mm. in breadth, and occupies much the same position as in Domestic Ruminants in the angle between the oesophagus the hinder part of the larynx and the trachea.

The Lungs (text-fig. 18).

The chief subdivision of the lungs follows the plan common to Ruminants, there being two lobes to the left lung and three and an azygos lobe to the right. The upper lobe of the right lung is partially divided into two minor lobes, the upper of which (text-fig. 18, *r.a.l.*¹) is the larger of the two, and is bent in the

characteristic Ruminant way transversely across the front of the heart. The lower (text-fig. 18, *r.a.l.*²) is leaf-like and resembles the same lobule in the Sheep or Goat, but is relatively larger. The middle and lower lobes and the azygos lobe resemble very closely those of the Goat.

Text-figure 18.

The lungs of *Okapia johnstoni*, ventral aspect.

b.l.a.l., bronchus of left apical lobe; *b.r.a.l.*, bronchus of right apical lobe; *l.a.*, azygos lobe; *l.a.l.*¹, left apical lobe, longitudinal process; *l.a.l.*², left apical lobe, transverse or cardiac process; *l.i.l.*, left inferior lobe; *l.i.l.a.*, cardiac appendage of left inferior lobe; *r.a.l.*¹, right apical lobe, transverse process; *r.a.l.*², right apical lobe, cardiac process; *r.i.l.*, right inferior lobe; *r.m.l.*, right median or cardiac lobe; *tr.*, trachea.

The upper lobe of the left lung is very similar to that of the Goat or Sheep, except for the greater length of its anterior

(text-fig. 18, *l.a.l.*¹) (longitudinal) lobule. The lower lobe (text-fig. 18, *l.i.l.*) is remarkably prolonged at its upper and outer angle, forming a long finger-like cardiac process (text-fig. 18, *l.i.l.a.*) that lies alongside the lower (transverse) lobule of the upper lobe (text-fig. 18, *l.a.l.*²), bound to it by a fold of pleural membrane. In the natural position these two elongated lobules embrace the left side of the heart.

The trachea, chief bronchial tubes, and pulmonary vessels call for no particular notice, as they resemble closely those of the Sheep.

The Heart.

The heart has a long narrow form, and measures 140 mm. in total length from base to apex, and 95 mm. in breadth at the upper part of the ventricles. The length of the ventricular portion is 120 mm.

It is of the same type as that of other Ruminants. In dissecting it, the muscoli papillares of both atrio-ventricular valves gave one the impression of being more than ordinarily developed, particularly as regards the muscular swelling that forms the foundation of those of the anterior cusp of the mitral valve. The wall of the left ventricle seemed also to be thick for a heart of the size.

The moderator band in the right ventricle is noticeably small. The great arteries spring from the arch of the aorta by a single large innominate trunk, as in other narrow-chested Ungulates. Between the aorta and pulmonary artery is a large vestige of the ductus arteriosus.

There is at the root of the aorta in Ruminants a very characteristic splinter of bone (*os cordis*) supporting the attachment of one of the cusps of the aortic valve. In the Okapi this bone is represented by a plate of cartilage, but whether its unossified condition is a permanent character or is due to youth it is difficult to say definitely, but it should be noted that in the calf ossification * sets in almost immediately after birth, and that in *Antilocapra* † the *os cordis* is permanently cartilaginous.

The Thymus Body.

The thymus is a relatively small triangular mass of tissue attached by a fold of membrane to the antero-ventral surface of the pericardium. It measures 64 mm. in length × 55 mm. in breadth at its posterior end.

The Stomach ‡ (text-figs. 19, 20, 21, 22, 23).

In its general form (text-fig. 19) the stomach of the Okapi resembles that of the Giraffe and many Antelopes more nearly

* Vaerst, "Herzknochen bei Wiederkäuern," Deutsch. Zeitschr. f. Tiermedizin, Bd. 30, 1888, p. 53.

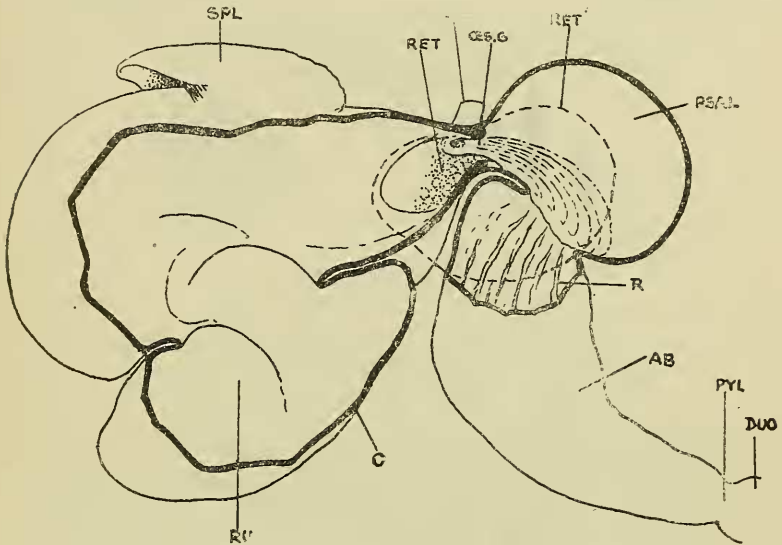
† Murie, Proc. Zool. Soc. 1870, p. 348.

‡ Garrod, Proc. Zool. Soc. 1877, p. 5.

than that of the various other Ruminants figured by Cordier*. All four chambers (rumen, reticulum, psalterium, abomasum) are fully developed.

The paunch (rumen) is subdivided by folds into secondary chambers in a manner similar to that of Domestic Ruminants, and is lined throughout by coarse papillæ (text-fig. 20), mostly of large size and flattened lanceolate form, like those in the rumen of the Giraffe. Upon the free edges of the dividing partitions the papillæ are reduced in height and resemble flat scale-like plates rather than papillæ.

Text-figure 19.



Outline of the stomach of *Okapia*, with the cavities opened.

ab., abomasum; *duo.*, duodenal dilatation; *æs.*, œsophagus; *æs.g.*, œsophageal gutter; *psal.*, psalterium; *pyl.*, pylorus; *r.*, longitudinal rugæ in abomasum; *ret.*, reticulum seen through opening from the rumen; *ret.*', outline of the reticulum; *spl.*, spleen.

The reticulum is a roomy, oval chamber, and is remarkable, like that of the Giraffe and *Antilocapra* †, for the extreme shallowness of its cells (text-fig. 21). In this particular it is approached by the reticulum of many Deer, and offers a striking contrast to that of Domestic Ruminants and the majority of Antelopes.

The psalterium is large, of about the same size as the reticulum, and contains some 14 chief laminae. The spaces between

* Cordier, Ann. des Sci. Nat. t. xv. 1893, pl. 6.

† Murie, Proc. Zool. Soc. 1870, p. 349.

the chief laminae are occupied by others of less height, constituting according to their size and position secondary, tertiary, and quaternary series.

The position and height of the different series are shown to scale in the accompanying diagram (text-fig. 23). It is to be noticed that of the quaternary series those only interposed between the secondary and tertiary series are represented by definite laminae. Those between the tertiary and primary, when they are represented at all (and they apparently are not in every case), are indicated only by a row of minute papillae (text-fig. 23, *p.*), as the whole quaternary series is in the Giraffe and certain other Ruminants*.

Text-figure 20.

Text-fig. 20.—Papillae of rumen, $\times 2$.

Text-figure 21.



Text-fig. 21.—Cell of reticulum, nat. size.

Text-figure 22.



Specialised papillae of oesophageal gutter, nat. size.

L., lamina of psalterium; *æ.s.g.*, roof of oesophageal gutter.

Towards the oesophagus the laminae gradually fade away, and are succeeded by rows of enlarged papillae similar in character but not in size to those that cover the surface of all the laminae. Some of these papillae are enormously developed (text-fig. 22) and form, when the oesophageal gutter is closed, a coarse filter to prevent unsuitable food from passing into the psalterium.

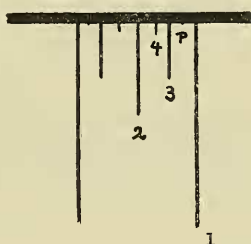
Papillae similar to these, though fewer in number and smaller in size, are present in the stomach of the adult Ox, at the entry of the oesophageal gutter into the psalterium.

* Garrod, Proc. Zool. Soc. 1877, p. 5.

In the Okapi each of these special papillæ of the œsophageal gutter consists, like those on the free margin of the leaves of the psalterium, of a fleshy base and a horny apex. The separation of the base from the apex is quite abrupt and clear, giving to the papilla the appearance of a long horny rod set upon the summit of a rounded fleshy boss.

The digestive stomach (abomasum) calls for no particular comment. Its walls become gradually more and more muscular towards the pylorus, beyond which the commencement of the duodenum is marked, as in other Ruminants, by a sudden dilatation. The lining membrane, towards the cardiac end, is longitudinally folded.

Text-figure 23.



Diagram, to scale, of laminae of psalterium.

1, 2, 3, 4, laminae of primary, secondary, tertiary, and quaternary series.

p., lamina of quaternary series represented by row of papillæ.

In the small portion of œsophagus preserved there was found a mass of partly masticated food. This was composed of small fragments of the leaves of trees. Though the fragments were too small to offer much likelihood of detailed identification, Mr. L. A. Boodle, of the Jodrell Laboratory, Kew Gardens, most kindly undertook to examine them. He reports that they "consist, chiefly at any rate, of fragments of Dicotyledonous plants, grasses being apparently absent. A few specimens show considerable resemblance to leaflets of certain Leguminosæ, but these and the fragments of other plants present have not been identified. No definite opinion has been arrived at as to the stature of the plants concerned."

This report, in the apparent absence of grass, agrees with the field observations made by Dr. Christy. He says that the animal "feeds chiefly on the small leaves and twigs of trees." "It does not eat grass, but does browse on the coarse herbage on the outskirts of the forest" *.

* Quoted from 'The Field,' July 10, 1915, by Sir H. H. Johnston, 'Nature,' Aug. 16, 1915, p. 714; see also to the same effect, Wilmet, C.R. Acad. Sci. Paris, 1913, vol. 156, p. 2007.

The Spleen.

The spleen (text-fig. 19, *spl.*) is massive and wedge-shaped, and is situated, as in other Ruminants, upon the left anterior surface of the paunch, adherent by its thick end to the diaphragm and with its narrow edge projecting freely to the left into the abdominal cavity.

The Colic Coil.

The colic coil is flat, not conical as in the Giraffe, and is almost circular, measuring 190 mm. in diameter. The gut of which it is constituted is relatively narrow (20 mm. in diameter), and is arranged in $3\frac{1}{2}$ concentric and $3\frac{1}{2}$ excentric coils. This number appears to be high. In Antelopes of which I have seen records* it apparently varies from 1 to 3, in the Ox it is $1\frac{1}{2}$, in *Antilocapra* 3 †, and in the Giraffe may be as many as 4 ‡.

In judging of the bearing of the above anatomical facts, it must be borne in mind that they are records of one individual only, but assuming that they fairly represent the condition normal for the species, the following points seem to be most worthy of note:—

A. In comparison with the Giraffe:

1. The form and superficial anatomy of the tongue.
2. The condition of the geniohyoid and genioglossus muscles.
3. The occipito-styloideus muscle and the form of the styloid bone.
4. The structure and form of the larynx.
5. The arrangement of the lingual arteries.
6. The general form of the stomach, and particularly the character of the reticulum.

B. As more or less characteristic of the Okapi:

1. The papillæ of the sublingual fringe.
2. The cartilaginous os cordis.
3. The elongation of the upper angle of the left lower lobe of the lungs.
4. The specialised papillæ in the œsophageal groove of the stomach.

* Beddard, Proc. Zool. Soc. 1909, i. p. 181; Mitchell, Trans. Zool. Soc. xvii. 1905, p. 473.

† Beddard, *l. c.*

‡ Owen, Trans. Zool. Soc. vol. ii. 1841, p. 227.